Designing Research for Theory and Practice

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***Abstract**: This paper reports on a doctoral study that has the dual aims of improving theory and practice within an Engineering Education context. The focus is on the development of students' graduate-level work skills as part of their Higher Education programme and a specific practice example provided an ideal study opportunity. Engaged scholarship, a research approach from Management Science, was selected as it provided a way to study practice that can generate both theoretical and practical knowledge. This paper sets out the strengths and challenges of applying an Engaged Scholarship approach and summarises its philosophical underpinnings. The research design is then evaluated, concluding that the design is internally consistent and suitable for this study. The authors then reflect on the implementation phase and highlight some of the practical challenges that have been encountered. These include engaging stakeholders, consolidating perspectives and the schedule of the programme being studied.*

Introduction

Of the many factors that influence a research design the starting point should be the research question (Flick 2014). The over-arching question of this 5 year, part-time Doctoral study was - How do you develop graduate-level work skills as part of Higher Education (HE) Programmes? The skills in question are those required to solve real world practical problems. These have been characterised (Hedlund and Sternberg 2000) as being poorly defined, lacking in information and having multiple correct answers.

This is an important question as there is increasing pressure on Higher Education Institutions (HEIs) to improve their ability to prepare students for work and there is the requirement of engineering programmes to prepare students for practice. "The fundamental purpose of Engineering Education is to build a knowledge base and attributes….that will develop the competencies required for independent practice" (International Engineering Alliance 2013).

Some HEIs are able to provide graduates that are considered more "industry ready". At the Institute for Manufacturing (IfM) there is an MPhil programme that claims to be able to prepare graduates for work in Industry (Ridgman and Wiggins 2003). This programme includes four different Short Industrial Placements (SIPs) of 2 weeks duration where students address real and significant practice problems for participating companies. These students undertake their first SIP after a four week Induction Module. One strand of this module is dedicated to developing the skills they need to solve practical problems in industry. This skills development activity, followed immediately by work based in a company, provided an opportunity to study the broad question in relation to practice that was considered effective.

Developing graduate-level work skills is a multidisciplinary and complex practice problem, too broad for a single Doctoral study. One way to narrow the scope is via a systematic literature review to identify a specific gap in knowledge. However, there are concerns (Van de Ven and Johnson 2006) that this academic approach is less useful for solving practice problems and that academia should be more engaged with practice.

Concerns about the declining engagement of academia with practice were raised earlier by Boyer (Boyer 1996). He used the term 'scholarship of engagement' to articulate the view of the engagement movement in US HE (Kenworthy-U'Ren 2005), that academia should focus more on solving real world problems. This type of scholarship was seen as being able to bridge gaps between theory and practice in Management Science (Van de Ven and Johnson 2006). So the Engaged Scholarship methodology was developed for research on complex problems and to create knowledge that advances theory and practice (Van de Ven 2007).

Out of a range of approaches, such as case-studies and ethnography, Engaged Scholarship provided a way to study the IfM practice that was judged most likely to contribute to both theory and practice. Informing both theory and practice is a recognised challenge for those undertaking research in profession related disciplines such as engineering, business and education (Van de Ven 2007). For academics their challenges are undertaking research relevant to practice and disseminating it such that it has an impact, and for practitioners their challenges are being aware of relevant research and then putting their practice into theory.

This paper sets out to evaluate if a research design using Engaged Scholarship was appropriate for this study and to answer the question - what strengths and challenges were identified when undertaking Engaged Scholarship research in an EE context?

The Engaged Scholarship Method

Engaged Scholarship is defined as a "participative form of research for obtaining the different perspectives of key stakeholders in studying complex problems" (Van de Ven 2007). This approach is designed to work across the theory-practice boundary and, through a pluralistic methodology, to advance knowledge by leveraging multiple perspectives.

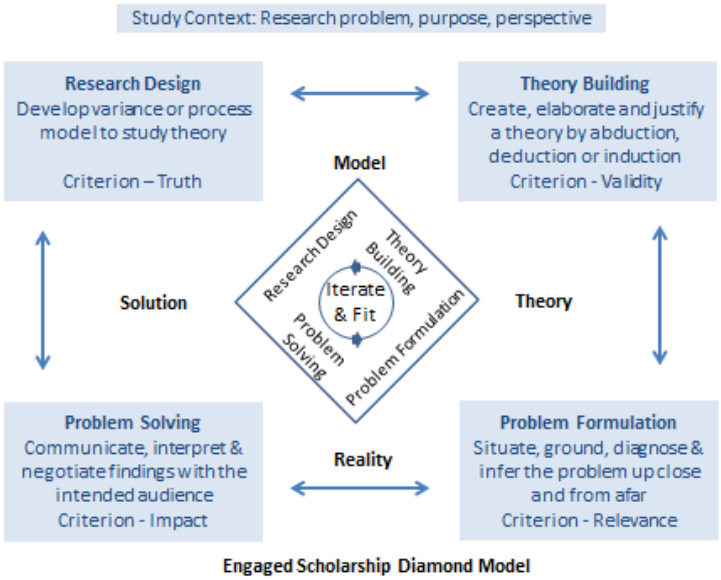

Figure 1. Engaged Scholarship Diamond Model (Van de Ven 2007)

Engaged Scholarship is considered to be a research methodology, or strategy, and consists of four fundamental activities, Problem Formulation, Theory Building, Research Design and Problem Solving. A summary of these activities and their relationship is shown in Figure 1.

Strengths and challenges

The main strengths and challenges were determined via an analysis of the Academy of Management Review paper (Van de Ven and Johnson 2006), the first chapter in "Engaged Scholarship in a professional school" (Van de Ven 2007) and a presentation given at London Business School (Van de Ven 2010). These are not presented in a rank order.

Strengths: The four main strengths of Engaged Scholarship identified in Table 1 below align with the aims and context of this research study.

Table 1: Engaged Scholarship Strengths

Strength	**How they are achieved**
A. Increased chance that the research will be applied in practice	A1. By engaging both researchers/scholars and practitioners
	A2. By framing a given problem as an instance of a more general case
B. Increases the likelihood that the research will advance knowledge for theory and practice	B1. Choice of research methods based on the study context and purpose
	B2. Arbitrage – a process of engaging with practitioners and working with different views
	B3 A research process of four interrelated activities - Problem formulation, Theory Building, Research Design and Problem Solving
	B4 Through research collaborations between multiple scholars and practitioners and addressing dual hurdles of quality and relevance
	B5 Triangulation of methods and models increases reliability and validity.
C. Facilitates under-standing of real world complex problems	C1. Use of arbitrage - between researchers and practitioners
	C2. Multiple investigators and perspectives
	C3. Multiple frames of reference
D. Suitable for inter-disciplinary research	D1. Pluralistic process (multi model/theory) & arbitrage

Challenges: Four main challenges were identified. They are presented in Table 2 below and then reviewed to evaluate if any were likely to cause serious problems for the research study.

Table 2: Engaged Scholarship Challenges

Challenge	**The importance of addressing the challenge**
E. Creating and managing an effective engagement between researchers and stakeholders	E1. To increase the likelihood that the research will be applied
	E2. To ensure all research stakeholders have clear expectations and are clear about their roles, responsibilities and use of study findings
	E3. To ensure the research team is balanced in terms of skills and background and all research collaborators are motivated and able to work on the project.
	E4. To ensure there is regular communication between collaborators, the collaborators get to know each other and that there are times set aside when the collaborators reflect on how the collaboration is performing.
	E5. To deal with conflicting views and interpersonal tensions arising through use of arbitrage
F. Time Interacting in the study	F1. To increase likelihood of making significant advances in knowledge
	F2. To build relationships and trust
	F3. To be able to observe directly
	F4. Longer study durations can enable deeper learning via repeated trials
G. Applying the Engaged Scholarship method to leverage its strengths	G1. Problem Formulation - to ground the research question/problem in observable phenomena, to appreciate and situate its multiple dimensions and to make sure that the size and scope of the study is achievable.
	G2. Theory Building - to develop plausible concepts and models, via triangulation, that represent the main aspects of the observed phenomena and provide a base for new theories to address the research question.
	G3. Research Design - to use appropriate methods to design the research and obtain empirical evidence of the concepts and plausible models for examining the question about the phenomenon to be examined
	G4. Problem Solving - to apply and disseminate the findings from the perspective of different academic and practitioner users – enabling others, not familiar with this type of research, to engage with the work.
H. Being reflexive and objective as a researcher	H1. To achieve internal and external validity
	H2. To ensure research goals are not compromised
	H3. To view the study from both a researcher and practitioner perspective
	H4. To undertake problem driven research

Challenge E: The researcher, although a novice researcher, is a mature postgraduate with significant experience of working in a large industrial company, multiple academic environments and has worked in and managed collaborative teams. As such the researcher is well equipped to tackle such a challenge. A key practice stakeholder is the academic who facilitates the skill development activities. This person is also the PhD Supervisor. This relationship did have the potential to cause issues, but were considered manageable.

Challenge F: The researcher is based at the IfM so there are plenty of opportunities to interact both formally and informally with most stakeholders. Also this is a part-time doctoral study over five years studying an annual programme, so repeated trials are possible.

Challenge G: Applying Engaged Scholarship without prior experience and as a novice researcher will require careful reference to the literature regarding the methodology and some discussions and checks with other researchers who have applied this in practice.

Challenge H: The range of experience of the researcher: in industrial roles, in lecturer/trainer roles and their experience of undertaking SIPs as a graduate student, coupled with an awareness of potential issues should enable this challenge to be managed.

McKelvey, a strong critic of Engaged Scholarship from a Management Science perspective, (McKelvey 2006) notes similarities with Action Research, a methodology used extensively in Education Research (Koshy 2010) to improve practice. He questions whether the addition of multiple aspects such as research collaborations, arbitrage, big questions and extended time periods will be achievable in real life company contexts and thus enable contributions to theory. EE contexts, however, are likely to offer a more stable context than companies and there is a greater probability that all stakeholders will be aligned on the goals of the work.

The largest challenge identified was applying the Engaged Scholarship methodology which forms part of a high level research design. Whilst methodology and method aspects have been discussed, the underlying philosophical perspectives of Engaged Scholarship have not.

Philosophical aspects of Engaged Scholarship

The philosophical underpinnings of Engaged Scholarship are more complex than those of most other methodologies (Bechara and Van der Ven 2007) and there is only space for a short summary in this paper. Engaged scholarship adopts a philosophy that includes, and integrates, aspects of what might traditionally be considered alternative philosophies, incorporating key ideas from positivism, relativism, pragmatism and realism. Ontologically, Engaged Scholarship adopts the critical realist position of Bhaskar, with its mid positioning between positivism and relativism, and the realistic pragmatism position of Rescher. Epistemologically it adopts Campbells' relativist evolutionary position.

The Engaged Scholarship position is summarised (Van de Ven 2010) as:

- There is a real world out there, but our understanding of it is limited
- All facts, observations and data are theory laden
- Social science has no absolute, universal, error-free truths or laws
- No form of inquiry can be value free and impartial
- Knowing a complex reality demands use of multiple perspectives
- Robust knowledge is invariant (in common) across multiple models
- Models that better fit the problems that they are intended to solve are selected, producing an evolutionary growth of knowledge.

The above statements align with the positions of the researcher and appear to be internally consistent. However the authors acknowledge that their expertise in this area is limited.

Evaluating the quality of the research design

It is necessary to address the quality of a study at a general level (Bernhard and Baillie 2013). Six tentative criteria were proposed at the level of study following a review of quality criteria (Bernhard and Baillie 2013). These are presented in Table 3 below as criteria 1 to 6.

These criteria appear to have been developed from a reviewer perspective. A researcher in the process of setting out a research design also has to consider whether it will enable the research question to be answered and a significant contribution to be generated. These criteria form part of the list by (Tracy 2010) and are added to Table 3 below as criteria 7 and 8. An explanation is provided on how each criteria is addressed in this study.

Table 3: Criteria to evaluate the quality of an overall study

Criteria	Explanation	How this is addressed for this research
Research question	Worthy topic: relevant, timely, significant, interesting	Development of skills in HE is a nationally and internationally recognised issue and is of particular concern for those providing initial professional education in applied disciplines such as engineering
Internal consistency of a study	Consistency between research question, methodology, epistemology and ontology	There is a clear fit between the research question and methodology. The methodology is understood in terms of its epistemology and ontology positions and is judged to be internally consistent
Perspective awareness	Awareness of how the researcher views his/ her subject	The perspective of the researcher is understood and articulated. This awareness will enable associated limitations to be considered throughout the research
Informed by theory and literature	Significant research cannot be performed without being informed by literature	The study was informed by literature in relevant fields. The Engaged Scholarship methodology requires input from literature at multiple times.
Upholding ethical values	With regard to all stakeholders related to the research	The interests of all stakeholders were respected. Major ethical dilemmas were unlikely as the research should benefit all stakeholders.
Acknowledging different traditions and cultures	Respect and awareness of the perspective of other researchers	The research was carried out whilst being sensitive that many in Engineering are unfamiliar with social science research. Explanations on method and perspectives on knowledge would be required.
Fit for purpose	Design likely to enable the research question to be answered	An Engaged Scholarship methodology is likely to be effective in informing both theory and practice which is the purpose of this study.
Significant contribution	The research design has the potential to generate a significant contribution	An Engaged Scholarship methodology was selected as it was judged to be most likely to generate the most significant contribution.

It is concluded that the research design proposed is a coherent and appropriate approach that is aligned to the context and aims of this study. With this doctoral study approaching completion, it is now possible to reflect on the strengths and challenges actually experienced.

Implementing the Research Design

Although it is possible to start with any of the four activities in the Engaged Scholarship process (see Figure 1) this research started with the problem formulation. Three sequential rounds of the Engaged Scholarship methodology were used in this study and are described in Table 4 overleaf. Each of the four research activities will be reviewed in turn to reflect on the key challenges and how these were addressed across all three rounds.

Problem formulation. A key initial challenge was selecting an aspect of the overall problem, of suitable size and scope, to be studied as the first examinable part of a doctoral study. Fortunately the teaching of practical problem skills in the Induction Module happened at an appropriate time! This teaching was not seen as a “problem”, but as an opportunity to evaluate this practice in terms of theory and identify further research questions. In the other rounds, a challenge was finding appropriate academic terms e.g. the practice of ‘working with information’ maps onto the academic field of ‘personal knowledge management’. Systematic literature reviews and talking to researchers from other disciplines helped to deal with this.

Theory building. Combining different perspectives appropriately was a challenge e.g. an experienced consultants approach to practical problem solving and that of a novice engineer.

A question found to be helpful was ‘how can this be represented visually in a way that the audience can easily engage with?’ As an engineer visual representations appeal as they are a familiar way of communicating e.g. drawings, process flow diagrams etc. and they force the development of some really clear boundaries and linkages between different elements.

Table 4: The rounds of Engaged Scholarship in this study

Round	Engaged Scholarship research activity	Research activities undertaken
1	Problem Formulation	Interviewed multiple stakeholders, captured key facts, reviewed literature and formed an initial research question – What is required to teach practical problem solving skills in a HE classroom setting?
	Theory Building	Constructed a conceptual Skills Development Framework (SDF) from literature.
	Research Design	Designed and carried out an exploratory case study comparing the SDF to a set activities delivered to teach practical problem solving skills
	Problem Solving	Determined that the definition of practical problem solving skills used was poor, reflection activities were weak and that aspects were missing from the SDF.
Disseminate findings (Shawcross and Ridgman 2012)		
2	Problem Formulation	Analysed two different approaches for defining skills and selected an activity approach. The research question identified was - What activities are undertaken by students during a SIP?
	Theory Building	Constructed a conceptual SIP activity framework from literature.
	Research Design	Employed an Action Research design to cover all 80 SIPs in one academic year. This involved four cycles, each with an increased level of scrutiny, multiple methods and student and tutor perspectives.
	Problem Solving	Identified two types of activities: ‘problem solving’ - which were successfully captured, and ‘through SIP’ – which were found to be extensive and were only partially captured.
Disseminate findings (Shawcross and Ridgman 2014) - a		
3	Problem Formulation	Determined that the five ‘through SIP’ activity groups required capturing individually and at a holistic level.
	Theory Building	Constructed conceptual ‘through SIP’ activity group frameworks from literature for all five activity groups.
	Research Design	Employed an Action Research design covering all SIPs over two years involving, multiple methods as well as student and tutor perspectives.
	Problem Solving	Captured ‘Through SIP’ activity groups but visual representations require further work.
Disseminate findings (First cycle only) (Shawcross and Ridgman 2014) - b		

Research Design. In each round the design took into account that stakeholders were busy, with methods chosen deemed effective in terms of time and effort. Two key questions were: What data is really needed? In what ways might the data be collected to involve multiple stakeholders with the minimum investment of their time? The first of these questions is essential to critically evaluate the theoretical perspective under test. In rounds 2 and 3 this resulted in individual questions initially and, as the research outcomes developed, group activities were found to be more effective in increasing the level of critical challenge.

It was anticipated that the students would engage with this research as SIPs are a significant reason for taking the programme and account for 40% of the overall mark. The majority of research activities were conducted within course hours to make it convenient for students to contribute. This strategy consistently achieved response rates of over 90% and, on multiple occasions, 100%. Some research activities did involve students outside of teaching time, when moving a survey from in-class on paper, to out of class online, the response rate fell to 74%. However, the most time-consuming data recording was during a SIP and a response rate of 78% was achieved. This was attributed to making this data collection as painless as

practical and the quality of the relationship developed with this cohort. Students were kept informed about the research and were provided with any findings they might find helpful.

Problem solving involved a critical evaluation of the data and results, firstly by the researcher, then with the supervisor and then sometimes with the students where there were concerns or conflicting perspectives. Some of the key questions used at this stage were: What results are unexpected or conflicting? What is this data telling and not telling me? What perspectives have been missed? At all stages both the researcher and the supervisor independently reviewed the raw data. The researcher then analysed the data and proposed results which were then discussed and agreed findings negotiated.

Each round of the Engaged Scholarship methodology generated multiple findings and presented further questions. The choice of question for the next round was made on the basis of its potential to make the most significant contribution. At the end of Round 1 the choice was to focus on defining skills for SIPs where there was a larger gap in knowledge rather than on improving student reflection where there is an extensive literature already.

Other challenges. There were multiple times when differences of perspective occurred as predicted in Table 3 E5. During Round 3, differences emerged whilst adapting a project management practice-based framework to the SIP context. In this case the research design for testing this framework with the students probed specifically into this issue and enabled appropriate evidence to be collected to resolve the conflict. Evidence was a useful tool on other occasions to counter what appeared to be strong SIP Tutor opinions. Other conflicts of perspective were more difficult to resolve – these were often down to different backgrounds, experience and in particular the use of the same terms but meaning different things.

Disseminating findings from each round proved valuable to reflect on the theory and practice contributions and to engage in a broader peer review process. Aspects of this research have been presented to six different UK and International audiences including SRHE 2012, SEFI 2013 and 2014 and two journal papers are published. This research has also informed changes in practice with improvements made to reflection activities and explaining SIPs.

Discussion

Strengths of Engaged Scholarship

The Engaged Scholarship approach was chosen as its strengths, as described in the literature, aligned with the aims of the study. Care was taken to employ the strategies identified in Table 1 to enable the strengths to be realised. Of these strategies C2 the “multiple investigators” aspect is the one potentially compromised as this research was done as a doctoral study. To counter this multiple perspectives were sought throughout the study from others with interests and experience in teaching practical problem solving skills.

Engaged Scholarship has only been applied to a small complex practice problem so claims that this method (Van de Ven 2007) can be applied to large complex problems (strength C in table 1) cannot be discussed. However the authors are confident that the results so far have helped to understand a complex practice problem and with some aspects already implemented in practice, strength A has been realised at a local level.

In terms of strengths B & D, these will be formally judged when the PhD thesis is complete. The strategy B1 giving the freedom to select from, and apply, a range of different social science research methods appropriate to the problem being addressed provided valuable opportunities to develop as a researcher.

Challenges of Engaged Scholarship

Challenge E (see Table 2) involved creating and maintaining the engagement with the stakeholders. The most significant issue was dealing with conflicting perspectives which has already been discussed. Having established relationships at the beginning of the study with

many of the academic stakeholders was a major advantage. However new relationships had to be developed each year with the students and some in each cohort did not really engage with any skill development activities that were not directly linked to assessment. Different mechanisms were tried to promote deeper levels of engagement with post SIP facilitated discussions and focus groups being found to be the most insightful.

Challenge F - spending time in the study - was overcome largely by contextual factors. The co-location of the researcher and the programme being investigated provided easy access to the stakeholders and the five year time horizon enabled multiple rounds of research.

Challenge G. Applying new methodologies is always challenging – like making a new recipe - it takes longer than you anticipate and sometimes the instructions only become clear during the process. Of the four research activities it was the theory building and research design that were least familiar to the researcher and where the most effort was required to make sure a quality study was undertaken. The annual academic programme with its fixed schedule of teaching and SIPs drove the research forward as it provided hard deadlines. Whilst helpful in maintaining momentum this also meant that sometimes plans had to be redrawn to accommodate issues that arose. The work on 'through SIP' activities took much longer than anticipated which resulted in some planned aspects of the work not taking place.

Challenge H. Being reflexive and objective is essential. For the researcher, the balance between developing theory and improving practice was more challenging than dealing with conflicting data or perspectives due to the researcher being a more experienced practitioner and teacher than researcher. So the guidance and questions from the supervisor were key.

One feature of this methodology is that you are limited to how far ahead you can plan as you need to complete a full round of activities to inform the following round. The long duration of the work makes it important to be able to step out of the operational level and reflect on whether you are still heading in the right direction and aligned with the overall research aims.

Opportunities for applying Engaged Scholarship

The fact that this research was undertaken on a part-time basis suggests that researchers, even with significant commitments, could contribute to projects of this nature providing they have the appropriate skills e.g. working with conflicting views and experience.

Applying Engaged Scholarship has been a valuable learning experience, requiring the researcher to appreciate a broad range of methods and apply several. It has also enabled a greater appreciation of how theory and practice can work together to the benefit of both.

Conclusions

The design of this engaged scholarship research was able to address the criteria presented in Table 3 for assessing the quality of a study. This methodology does pose challenges though related to perspective awareness and finding the relevant academic literature.

Three rounds of engaged scholarship have been carried out and each round succeeded in its objectives of building further understanding and contributing to IfM practice.

Of the four strengths claimed for Engaged Scholarship B (advancing knowledge) and C (facilitating understanding) were clearly demonstrated. A (increased chance of application) was true in the local area of the study but remains untested at a broader level. D (suitable for interdisciplinary research) was only tested to a limited extent as the disciplines drawn on in this research were already closely related.

In terms of the challenges E (effective engagement) and F (time) gave rise to no significant issues. G (applying the method) was a challenge because developing an understanding of the methodology while simultaneously using it adds additional complexity. H (objectivity) is probably the greatest challenge of the method because the greater intimacy with the subject and engagement with the practice make it much harder to recognise hidden bias.

A challenge in increasing the uptake of EE Research outcomes is convincing colleagues, whose research background is primarily engineering science, that the work has similar rigour. The Engaged Scholarship method provides an opportunity to demonstrate that rigour, while still addressing complex theory/practice boundary spanning issues.

Recommendations and further work

Engaged Scholarship should be an appropriate approach for other studies in Engineering Education with similar aims. Collaborations with those familiar with this methodology and social science research might be an effective way of undertaking such research in practice and overcoming traditional research boundaries.

The authors plan to continue their work to implement the findings in practice and undertake research to address the unanswered questions parked on the journey so far.

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